CPOE Impact on Hospital Length of Stay and Acute Readmission

S. Luke Webster MD and George A. Gellert, MD, MPH, MPA
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Speaker Introduction

S. Luke Webster, MD
System CMIO and Vice President

George A. Gellert, MD, MPH, MPA
Associate System CMIO
Regional CMIO, Santa Rosa

CHRISTUS Health
Dallas and San Antonio, TX
Co-authors and Collaborators on This Work

Leslie Stewart, PharmD
Mavis Girlinghouse, MS
John A. Gillean, MD

All CHRISTUS Health
Conflict of Interest

S. Luke Webster, MD
George A. Gellert, MD, MPH, MPA

Have no real or apparent conflicts of interest to report
Agenda

- Introduction and Background
- Methods
- Results
- Discussion and Conclusions
- Questions and Contact Information
Learning Objectives

• Describe the overall patient safety and clinical value proposition of Computerized Physician Order Entry (CPOE)

• Identify the methodology utilized to evaluate the impact of CPOE on key patient care outcomes, namely length of stay and acute 30 day hospital readmission rate and understand why other comparative effectiveness evaluation strategies, such as randomized clinical trials, are not readily deployable

• Assess the nature and magnitude of the impact of CPOE on patient LOS and acute hospital readmission as outlined by the study findings, and the implications in terms of leveraging such data to improve CPOE adoption in audience members’ facilities

• Recognize the complexity and limitations of research on CPOE outcomes and the utility of statistical modeling to identify patient benefits

• Discuss how these findings can be leveraged to advance CPOE adoption among physicians at your hospital or hospital system
Benefits Realized for Health IT Value: STEPs

• **S - Satisfaction** – CPOE quantifiably and demonstrably improves clinical end user care performance, and insofar as clinical information technology benefits the safety and quality of patient care, end user satisfaction will also increase.

• **T - Treatment/Clinical** - Successful implementation of CPOE improves care safety, and reduces both length of stay and acute hospital readmission rates.

• **E – Electronic Information/Data** - Successful implementation and adoption of CPOE as one major focus of clinical information technology, it is centrally concerned with electronic information and data.

• **P - Patient Engagement/Population Management** - Effective, strong adoption of CPOE and related clinical information technology enables higher quality, more focused patient engagement and population management.

• **S – Savings** - Successful implementation of CPOE, through its positive impact on patient care outcomes, yields substantial savings in terms of preventable healthcare expenditures.
Introduction

• The impact of CPOE has been financial, operational and clinical
• Immediate clinical impact on patient safety has been elimination of illegible handwritten orders
• Financially, Health Informatics has secured over $100 million in Meaningful Use incentive dollars for the organization
• Other financial gains from more precise, less duplicative or unnecessary care delivery derived from clinical decision support (CDS)
Introduction

• CPOE has become an expected standard of clinical care in U.S. hospital care delivery

• While studies demonstrate positive CPOE impact on hospital processes (e.g., lab turnaround time, medication error reduction), few focus on global patient outcomes such as mortality, LOS or hospital readmission

• We will review design, data collection, statistical analyses, findings and implications of a study assessing changes in LOS and acute 30-day hospital readmission with increasing use of CPOE
Background

• CHRISTUS Health is a non-profit multi-state system of more than 380 services and 47 hospitals with over 15,000 physicians
• Began CPOE implementation in January 2012
• EHR deployed is MEDITECH Client Server Version 5.66
• Most facilities adopted CPOE well; enterprise CPOE use rate of 76%+
• CPOE use not mandatory, but expected standard of care and best practice
Methods – Study Design

• Study focused on patient length of stay (LOS) and 30-day acute hospital readmissions in 22 hospitals between April 2014 and July 2015 (the dataset)

• Statistical approach from health services research/epidemiology (logistic regression and model building)

• These CPOE analyses among largest patient denominators in literature

• Regressed each outcome on primary variable of interest – facility CPOE use rate – and other variables influencing patient outcomes (severity of illness, mortality risk, admission type, disease category, if admission for surgery)
Methods – Study Design

• Statistical models controlled for key confounding factors that could bias findings:
  – surgical or non-surgical treatment
  – history of 30-day readmission
  – 3M risk of mortality index
  – encounter CM Index
  -- DRG disease category
  -- 3M severity of illness index
  -- admission type
  -- two-way interactions of these factors
Methods – Study Design

• Statistical models were validated analytically using statistical tests, a “hold-out” sample, and comparison to actual outcomes observed in the population

• Each hospital adopted CPOE at different times and at different rates

• The study employed a retrospective time-series design, where month by month CPOE adoption rates in each hospital were utilized as predictors of clinical outcomes

• 283,117 admissions were examined for hospital-level information, including number of admissions, admission days and % CPOE adoption
Methods – Study Design

• Different admission types were collapsed into - Elective or Emergency/Trauma/Urgent – to make statistical analysis manageable and prevent over-parameterizing

• 25 Major Disease Categories (MDCs) were collapsed into 3 MDCs based upon how frequently encounters coded with the MDC resulted in death

• The most Common MDCs (CMDC) associated with death were classified into CMDC1, the next most common classified into CMDC 2, and the least common into CMDC 3
Methods – Study Design

• To prevent censoring bias in analyses, LOS was defined as the number of whole days between admission and discharge only for patients alive at time of discharge, no deaths

• 30-day readmission was calculated using the definition provided by the Centers for Medicare & Medicaid Services (CMS)

• All outcomes were associated with a single encounter, and patients could have multiple encounters
Methods – Definition of Primary Intervention and Independent Variables

• A hospital-level CPOE adoption rate was computed for each facility for each of the 28 months of study by obtaining % of orders issued via CPOE in each facility each month, across all patients.

• Encounter-level data then merged with institutional CPOE rates based on month of patient discharge (e.g., encounter record for a patient discharged in May 2014 was merged with May 2014 institutional CPOE rate).
Methods – Data Preparation

• EHRs queried for order-level, patient- and visit-level details

• Order level details included: order identifier, order date and time, order type, order source (CPOE vs. Non-CPOE), and order procedure category (Laboratory, Radiology, Pharmacy, or Other)

• Patient- and visit-level details included unique patient and visit identifier, admitting hospital, admission type (Elective, Emergency, Newborn, Trauma Center, Urgent), admission and discharge dates, discharge disposition, variables indicating patient expired in hospital, and if visit was a 30-day readmission (as defined by CMS)
Methods – Data Preparation

• Severity of illness (SOI) and risk of mortality (ROM) were examined

• SOI and ROM subclasses measured extent of physiologic/organ system loss of function and overall likelihood of death for a given visit taking into account complications and co-morbidities

• APR-DRG codes classified principal visit procedure as medical or surgical

• Dataset was cleansed of outlying observations, coding errors and inconsistencies, missing and unrealistic values
Methods – Statistical Model

• Two statistical models were applied for each outcome variable; all statistical models were built using SAS 9.4 genmod procedure with patient ID serving as the repeated measure.

• Data was modeled using generalized estimating equations (GEE) to account for dependence among observations within patients.

• Since the outcome in 30-day readmission model is binary - readmission vs. none - GEE logistic regression model was utilized.
Methods – Statistical Model

• LOS was measured as number of days from admission to discharge, with larger counts rare, so a GEE quasi-Poisson model was fit to the data.

• Each model was fit using an AR-1 working correlation structure, with Huber-White sandwich estimators for variance estimates and standard errors to reduce misspecification of working correlation structures.
Results – Hospital Length of Stay (LOS):

- A statistically significant decrease in mean LOS across all 4 illness levels of illness severity was observed, with 45%, 36%, 28% and 17% reductions in LOS from highest to lowest severity of illness, respectively (p < 0.05)
- The greatest reduction occurred among the most severely ill patients (45%)
- However, no matter how ill a patient was, their LOS in hospital was significantly and meaningfully reduced when the patient care team had higher CPOE use rates
Results – Mean LOS by CPOE Use & SOI (22 Hospitals)

SOI:
- Extreme
- Major
- Moderate
- Minor
Results – 30-Day Acute Hospital Readmission:

• For 30-day readmission rates, a 37.8% mean reduction in readmissions occurred within 7 of 9 (78% of) hospitals with sufficient data for analysis.

• These differences are statistically significant (p < 0.05 level) and are clinically meaningful.

• Two facilities had reduced readmission trends with increasing CPOE use, but did not achieve statistical significance.

• Mean reduction in readmission for all 9 hospitals was 30.2% (including the 2 facilities where differences were not yet statistically significant).
Results – 30-Day Readmission Rate by Facility and CPOE Use (9 Hospitals)
Discussion and Conclusions

- This study is one of the largest to date reporting statistically significant reductions in LOS and 30-day readmissions associated with CPOE use.
- CPOE appears to be conveying a strongly positive clinical impact on patients by reducing LOS and readmission.
- CPOE reduces significant health and injury risk occurring with hospitalization, its associated costs, and family, employment and psychological dislocations.
Discussion and Conclusions

• CPOE use was associated with a large, statistically significant decrease in length of stay (17-45%) across all 4 strata of illness severity in all hospitals evaluated.

• LOS reduction improves patients’ health status and well-being, reduces risks associated with hospital admission, and contributes to institutional and national efforts to downwards manage healthcare costs and financial risk.
Discussion and Conclusions

• CPOE use also associated with a large significant decrease (37.8%) in 30-day readmissions at 7 hospitals

• A powerful clinical impact on patients while also delivering financial value by reducing hospital losses due to non-reimbursed care for preventable readmissions

• LOS and acute readmission rates were decreased most among patients for whom CPOE was most frequently utilized (p<0.05 level)
Discussion and Conclusions

• CPOE use was associated with a particularly favorable impact on the sickest, highest resource consuming patients

• While the highest degree of CPOE utilization in the sickest patients yielded the greatest favorable clinical impact on LOS, CPOE also delivered patient value at lower use rates among less ill patients

• But no matter how ill a patient is, their LOS was significantly and meaningfully reduced when providers utilize CPOE to the greatest extent
Discussion and Conclusions

• The methodological difficulty of evaluating the impact of clinical information technology in vivo (and CPOE in particular) is significant.

• Scientific gold standard of prospective, comparative effectiveness research, randomized clinical trials, cannot be executed for logistical/ethical reasons.

• Instead used statistical models to assess for a positive clinical impact, controlling for most likely sources of systematic variation that could produce confounding and bias.
Discussion and Conclusions

• Development of statistical models to evaluate the impact of CPOE on LOS and acute hospital readmission is a complex, laborious undertaking.

• Offers a systematic ability to evaluate critical health information technology interventions not otherwise evaluable, such as CPOE.

• Extended periods of study are required to achieve adequate statistical power for outcomes analyses -- in this study only 9 hospitals could be evaluated for 30-day readmission because others lacked sufficient CPOE use during the 2 year+ study period to ensure model integrity.
Discussion and Conclusions

• Isolating impact of CPOE adoption from that of other patient care improvement programs, practice changes or other independent influences is a challenge

• A number of potentially influential and parallel occurring variables were beyond our analytic control

• E.g., a sepsis reduction initiative was implemented in a number of hospitals during the study period -- could have conveyed an independent favorable impact on LOS and/or risk of acute readmission
Discussion and Conclusions

• Nearly impossible to dissociate many such quality improvement efforts from CPOE, since CPOE has become the vehicle for achieving many critical changes in clinical management and best practice

• Thus, CPOE is systematically driving changes into care with unprecedented speed to achieve a pervasive impact throughout the enterprise, demanding nuanced evaluation

• Our robust control of SOI should mitigate these potential biases significantly
Discussion and Conclusions

• Changes in medical staffing, differences in the rate and timing of CPOE adoption across facilities, and other variations in clinical practice may have occurred during 28-month study period, and were not systematically evaluated.

• The strongly favorable findings of this and other studies cumulatively demonstrate a clear association of higher CPOE use with lower patient LOS and acute hospital readmissions, and suggests that CPOE should be the universal method of conveying patient care orders (unless a provider is physically unable to issue electronic orders).
Discussion and Conclusions

• Such studies should become an integral component of the education and advocacy process to promote universal CPOE adoption

• May be particularly useful where physicians remain resistant to CPOE adoption

• Utilizing population and clinical evidence which focuses on patient care outcomes to promote exclusive CPOE use and eliminate paper may resonate with the evidence-based orientation of physicians
Discussion and Conclusions

• A formidable evidence base may be more effective in driving CPOE adoption than institutional requirements or mandates, medical bylaw changes and other compellence tactics, because evidence appeals to providers’ core professional aspiration to deliver state of the art care to their patients.

• By decreasing LOS and hospital readmission rates, the implementation of CPOE by U.S. Health Informatics departments will convey a highly beneficial impact on facility/system clinical and financial performance as the nation shifts from volume to value based reimbursement.
Discussion and Conclusions

• While $100+ million in Meaningful Use dollars awarded to our organization for successful CPOE implementation was substantial, the delivery of a clinically mediated financial gain through CPOE will be recurrent and sustained for years.

• The cumulative evidence supporting CPOE as a best practice in healthcare is such that physicians are at risk of providing lower quality, less safe, less clinically effective and less cost-effective care to their patients when they reach for paper and pen rather than a mouse.
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Questions

Thank you for your attention and engagement!!

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For further information please contact:

• luke.webster@christushealth.org

• george.gellert@christushealth.org